FOLDING ELECTRONIC DEVICE WITH CONTINUOUS DISPLAY

BACKGROUND

Electronic devices are getting smaller all the time. The reduction in size of the device is followed by reduction in the size of a display that is utilized by the device. Shrinking the display too much reduces the amount of information that can be presented and may reduce the functionality of the device. Devices that have two halves that fold together (clamshells) provide the ability to modify the footprint of the device. When the device is folded together it will reduce the dimensions of the device in the direction it is folded. When the devices are opened they may provide additional user interface area (e.g., a clamshell phone may provide access to a keypad and display when opened).

FIG. **1** illustrates an example clamshell device **100** made up of two panels **101**, **102** connected together by a hinge assembly **103** that enables the device **100** to be folded-up. At least one of the panels **101**, **102** includes a processor (CPU), memory, power and input/output components. Electrical signals and power are passed between the panels **101**, **102**. Conventional LCD displays include a rigid glass panel so they cannot span the panels **101**, **102** and the hinge **103**. Accordingly, to increase the display footprint in a clamshell device **100** each of the panels **101**, **102** may include a display (displays **104**, **105** respectively). The displays **104**, **105** may be used to display different content. A Nintendo DS game is an example of a commercially available clamshell device that includes displays on each panel of the clamshell.

The example clamshell device **100** is acceptable when the individual displays **104**, **105** are used for different purposes and the sizes of the individual displays **104**, **105** are adequate for the respective purposes (e.g., Nintendo DS). However, the example clamshell device **100** does not provide a single, high-quality, integrated graphical image across the two displays.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the various embodiments will become apparent from the following detailed description in which:

FIG. **1** illustrates an example prior art clamshell device, according to one embodiment;

FIGS. **2**A-B illustrate an example clamshell device having a single display, according to one embodiment;

FIG. **3** illustrates an example single display clamshell device capable of avoiding a high stress region when the device is folded, according to one embodiment;

FIG. **4**A illustrates an example clamshell device where a display is not folded between panels when the device is closed, according to one embodiment;

FIG. **4**B illustrates an example roller used within an expanded portion the example clamshell device of FIG. **4**A, according to one embodiment;

FIG. **5**A illustrates an example clamshell device where a display is not folded between panels when the device is closed, according to one embodiment;

FIG. **5**B illustrates an example roller system within the example clamshell device of FIG. **5**A, according to one embodiment; and

FIG. **6** illustrates an example three paneled clamshell device, according to one embodiment.

DETAILED DESCRIPTION

The following description refers to the accompanying drawings. Among the various drawings the same reference numbers may be used to identify the same or similar elements. While the following description provides a thorough understanding of the various aspects of the claimed invention by setting forth specific details such as particular structures, architectures, interfaces, techniques, etc., such details are provided for purposes of explanation and should not be viewed as limiting. Moreover, those of skill in the art will, in light of the present disclosure, appreciate that various aspects of the invention claimed may be practiced in other examples or implementations that depart from these specific details. At certain junctures in the following disclosure descriptions of well known devices, circuits, and methods have been omitted to avoid clouding the description of the present invention with unnecessary detail.

FIGS. **2**A-B illustrate an example clamshell device **200** having a single display **210**. The device **200** includes two panels **220**, **230**, a hinge assembly **240** connecting the panels **220**, **230** and enabling the device **200** to close, and the display **210** extending across the two panels **220**, **230** and the hinge assembly **240**. The display **210** is a flexible display and may be constructed using display rendering materials that are flexible (e.g., organic light-emitting diodes (OLED)) and flexible display addressing circuitry (e.g., organic or inorganic transistor circuits). A variety of hinge mechanisms **240** may be used and are within the scope of the various embodiments described herein.

FIG. **2**A illustrates the device **200** in an open position. In the open position the display **210** lays flat across the two panels **220**, **230**. FIG. **2**B illustrates the device **200** being closed. When the device **200** is closed the display **210** folds over at or near the hinge assembly **240**. The fold creates a small radius of curvature for the display **210** resulting in a region **250** of high mechanical stress. The high stress region **250** may cause delamination and/or failure of the display rendering materials and/or the addressing circuitry.

A clamshell device that provides a single display but eliminates or at least reduces the high stress region would make the use of clamshell devices having a single display practical. The high stress region may be reduced or eliminated by preventing the display from being folded flat and creating the damagingly small radius of curvature.

FIG. **3** illustrates an example single display **310** clamshell device **300** capable of avoiding a high stress region when the device **300** is folded. The device **300** includes panels **320**, **330**, the flexible display **310**, and a hinge assembly **340**. The display **310** is connected to outer portions **350** (fixed display portion) of the panels **320**, **330** and is free from an inner portion **360** (free display portion) of the panels **320**, **330**. As illustrated, the free display portion **360** is between the dotted lines and the fixed display portions **350** are outside of the dotted lines (above top dotted line and below bottom dotted line). A cavity **370** may be formed at a center portion of the device **300**. The center portion where the cavity **370** is formed may be within the inner portion **360**. The cavity **370** may be formed by reducing the height of the panels **320**, **330** at the center portion. The hinge assemble **340** allows for folding the panels **320**, **330** and not blocking the cavity **370**. When the device **300** is folded, at least a portion of the free display portion **360** may escape into the cavity **370**, thus avoiding the damagingly small radius of curvature.

It should be noted that the diameter of the cavity **370** required to avoid strain-induced delamination does not necessarily need to be large (e.g., millimeters). The minimum diameter depends on factors such as the elastic modulus of the various materials.

When the device **300** is folded it is possible that the free display portion **360** may flex forward and not into the cavity